

WHAT IS CLAIMED IS:

1 1. A process for forming a patterned thin film structure on a
2 substrate, comprising:
3 printing a pattern on the substrate using a strippable material comprising
4 5-80% by weight of a re-dispersible particulate, the printed strippable
5 material defining an area on the substrate where the thin film structure is
6 to be formed by comprising a negative image of a decorative design to be
7 formed on the substrate using the thin film material, such that the printed
8 strippable material is present in areas on the substrate where the thin film
9 structure is not to be formed and the printed strippable material is
10 substantially not present in the area on the substrate where the thin film
11 structure is to be formed;
12 depositing a thin film of material on the patterned substrate; and
13 stripping the strippable material from the substrate;
14 whereby the strippable material and any thin film material formed thereon
15 are removed by said stripping leaving behind the thin film structure
16 formed on the substrate in the shape of said decorative design; and
17 wherein the substrate and the patterned thin film design formed thereon
18 are suitable for use as an in-mold decoration (IMD) decorated film.

1 2. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the strippable material comprises 10-
3 60% by weight of re-dispersible particulate.

1 3. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the strippable material comprises a
3 water soluble or water dispersible polymer as a binder.

1 4. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 3, wherein said water soluble or water dispersible
3 polymer is selected from the group consisting of polyvinyl alcohol,
4 polyvinylpyrrolidone, polyvinyl pyridine, polyacrylic acid, polymethacrylic acid,
5 polyacrylamide, polyethylene glycol, poly(ethylene-co-maleic anhydride), poly

6 (vinyl ether-co-maleic anhydride), poly(styrene-co-maleic anhydride),
7 poly(butylene-co-itaconic acid), PEOX, polystyrene sulfonate, cellulose
8 derivatives such as hydroxyethyl cellulose, hydroxypropyl cellulose, methyl
9 cellulose, carboxymethyl cellulose, xanthan gum, gum Arabic, gelatin, lecitin,
10 and their copolymers.

1 5. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 3, wherein said water soluble or water dispersible
3 polymer comprises a water dispersible polymer selected from the group
4 consisting of water- or alkaline-dispersible waxes, polyolefin, or acrylic latexes
5 or dispersions.

1 6. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the strippable material comprises a
3 solvent soluble or solvent dispersible polymer as a binder.

1 7. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the re-dispersible particulate is derived
3 from silica, CaCO_3 , CaSO_4 , BaSO_4 , Al_2O_3 , TiO_2 , hollow-spheres, non-film-
4 forming latexes or dispersions, inorganic pigment, or organic pigment.

1 8. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the particulate is a polymeric particle or
3 a polymeric composite particle.

1 9. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the strippable material comprises an
3 additive selected from the group consisting of surfactants, dyes, curing agents,
4 and plasticizers; whereby the presence of said additive facilitates the stripping of
5 the strippable material subsequent to the deposition of the thin film.

1 10. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of stripping comprises using a
3 solvent to remove the strippable material.

1 11. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 10, wherein the solvent is selected from the group
3 consisting of water, aqueous solutions, alcohols, ketones, esters, ethers,
4 amides, hydrocarbons, alkyl benzenes, pyrrolidones, sulfones, DMSO, and their
5 mixtures and derivatives.

1 12. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the thin film material is non-conductive.

1 13. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the thin film material is semi-conductive.

1 14. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the thin film material is conductive.

1 15. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 14, wherein the conductive thin film material is a
3 material selected from the group consisting of metals, metal oxides, and their
4 alloys and multilayer composites.

1 16. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 14, wherein the conductive material is a metal
3 selected from the group consisting of aluminum, copper, zinc, tin, molybdenum,
4 nickel, chromium, silver, gold, iron, indium, thallium, titanium, tantalum,
5 tungsten, rhodium, palladium, platinum and cobalt.

1 17. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 14, wherein the conductive material is a metal
3 oxide or sulfide selected from the group consisting of indium tin oxide (ITO),
4 indium zinc oxide (IZO), aluminum zinc oxide, gadolinium indium oxide, tin
5 oxide, fluorine-doped indium oxide or zinc sulfide.

1 18. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises sputtering.

1 19. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises vapor deposition.

1 20. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises vacuum deposition.

1 21. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises electroplating.

1 22. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises electro-less plating.

1 23. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of depositing a thin film
3 comprises electroforming.

1 24. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises
3 flexographic printing.

1 25. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises
3 driographic printing.

1 26. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises electro
3 photographic printing.

1 27. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises
3 lithographic printing.

1 28. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises gravure
3 printing.

1 29. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises thermal
3 printing.

1 30. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises inkjet
3 printing.

1 31. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of printing comprises screen
3 printing.

1 32. The process for forming a patterned thin film structure on a substrate
2 as recited in claim 1, wherein the step of printing comprises stamp printing.

1 33. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the substrate comprises a plastic
3 substrate.

1 34. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 33, wherein the plastic substrate comprises a
3 portion of a roll of plastic substrate.

1 35. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 34, wherein the process for forming a patterned
3 thin film structure on a substrate is a component part of a roll-to-roll process for
4 fabricating an in-mold decoration film.

1 36. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the substrate comprises a polyethylene
3 terephthalate (PET) film.

1 37. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 36, further comprising performing the following
3 steps prior to forming the patterned thin film structure on the substrate:

4 treating or coating the PET film with a release agent or coating; and

5 coating the treated or coated PET film with a durable layer to provide oil
6 and scratch resistance.

1 38. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 36, further comprising printing on the substrate a
3 second decorative design using a printable material other than the thin film
4 material.

1 39. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 36, further comprising coating the IMD decorated
3 film with an adhesive to form an in-mold transfer film.

1 40. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the substrate comprises a
3 polycarbonate (PC) substrate.

1 41. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 40, further comprising coating the decorated
3 substrate with a thin protective layer.

1 42. A process for forming a patterned thin film structure on a
2 substrate, comprising:
3 printing on the substrate with a printable first material a pattern that
4 defines the area where the thin film structure is to be formed by
5 comprising a positive image of a decorative design to be formed on the

6 substrate such that the printable first material is printed in the area where
7 the thin film structure is to be formed, the printable first material being
8 strippable using a first solvent;
9 overcoating the printed surface of the substrate with a second material
10 that is not strippable using the first solvent;
11 stripping the first material away using the first solvent in a process that
12 strips away the first material and any portions of the second material
13 formed on the first material without stripping away the portions of the
14 second material formed directly on the substrate, such that the second
15 material remains coated on the portions of the substrate where the first
16 material was not present, thereby defining the boundaries of the thin film
17 structure by comprising a negative image thereof such that the second
18 material is not present in and the first material has been stripped from the
19 area where the thin film structure is to be formed;
20 depositing a thin film layer on the patterned top surface of the substrate;
21 and
22 stripping the second material to form the thin film structure in the shape
23 of the decorative design;
24 wherein the substrate and the patterned thin film design formed thereon
25 are suitable for use as an in-mold decoration (IMD) decorated film.

1 43. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first material repels the second
3 material such that the second material fills in the areas of the substrate between
4 the areas where the first material has been printed without coating the areas
5 where the first material is present.

1 44. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first solvent is an aqueous solution
3 or water.

1 45. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first solvent is a non-aqueous
3 solvent or solution.

1 46. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first solvent is an aqueous basic
3 solution, and the step of stripping the second material comprises using a second
4 solvent comprising an aqueous acidic solution, an aqueous neutral solution, or
5 water.

1 47. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first solvent is an aqueous acidic
3 solution and the step of stripping the second material comprises using a second
4 solvent comprising an aqueous basic solution, an aqueous neutral solution, or
5 water.

1 48. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 42, wherein the first solvent is an aqueous neutral
3 solution or water and the step of stripping the second material comprises using
4 a second solvent comprising an aqueous acidic solution or an aqueous basic
5 solution.

1 49. A process for forming a patterned thin film structure on a
2 substrate, comprising:
3 printing a first pattern on a first surface of the substrate using a strippable
4 material comprising 10-60% by weight of a re-dispersible particulate, the
5 first pattern of strippable material defining an area on the first surface of
6 the substrate where a first thin film structure is to be formed;
7 depositing a thin film of thin film material on the patterned first surface of
8 the substrate;
9 stripping the first pattern of strippable material from the substrate;
10 printing a second pattern on a second surface of the substrate using a
11 strippable material comprising 10-60% by weight of a re-dispersible
12 particulate, the second pattern of strippable material defining an area on
13 the second surface of the substrate where a second thin film structure is
14 to be formed;

15 depositing a thin film of thin film material on the patterned second surface
16 of the substrate; and
17 stripping the second pattern of strippable material from the substrate;
18 whereby the first pattern of strippable material, the second pattern of
19 strippable material, and any thin film material formed on either the first or
20 the second pattern of strippable material are removed leaving behind the
21 first thin film structure on the first surface of the substrate and the second
22 thin film structure on the second surface of the substrate;
23 wherein the first thin film structure comprises a first decorative design,
24 the second thin film structure comprises a second decorative design, and
25 the substrate and the patterned thin film designs formed thereon are
26 suitable for use as an in-mold decoration (IMD) decorated film.

1 50. A process for forming a patterned thin film structure on a
2 substrate, comprising:
3 printing a first pattern on a first surface of the substrate using a strippable
4 material comprising 10-60% by weight of a re-dispersible particulate, the
5 first pattern of strippable material defining an area on the first surface of
6 the substrate where a first thin film structure is to be formed;
7 printing a second pattern on a second surface of the substrate using a
8 strippable material comprising 10-60% by weight of a re-dispersible
9 particulate, the second pattern of strippable material defining an area on
10 the second surface of the substrate where a second conductive thin film
11 structure is to be formed;
12 depositing a thin film of material on the patterned first surface and on the
13 patterned second surface of the substrate; and
14 stripping the first pattern and second pattern of strippable material from
15 the substrate;
16 whereby the first pattern of strippable material, the second pattern of
17 strippable material, and any thin film material formed on either the first or
18 the second pattern of strippable material are removed leaving behind the
19 first thin film structure on the first surface of the substrate and the second
20 thin film structure on the second surface of the substrate; and

21 wherein the first thin film structure comprises a first decorative design,
22 the second thin film structure comprises a second decorative design, and
23 the substrate and the patterned thin film designs formed thereon are
24 suitable for use as an in-mold decoration (IMD) decorated film.

1 51. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of stripping comprises using
3 solvent to remove the strippable material.

1 52. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of stripping comprises using
3 mechanical pressure to remove the strippable material.

1 53. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 52, wherein using mechanical pressure comprises
3 brushing.

1 54. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 52, wherein using mechanical pressure comprises
3 using a spray nozzle.

1 55. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of stripping comprises:
3 applying an adhesive layer having a higher adhesive strength with
4 respect to the thin film and/or strippable material than the adhesive
5 strength of the strippable material to the substrate; and
6 removing the strippable material and any thin film formed thereon by
7 peeling off the adhesive layer.

1 56. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 1, wherein the step of stripping comprises:
3 applying an adhesive layer to the substrate after the thin film deposition
4 step; and removing the thin film on the area with the first printed material
5 by peeling off the adhesive layer.

1 57. The method of claim 56, wherein the cohesion strength of the thin
2 film and the adhesion strength between thin film and the substrate are stronger
3 than any of the three forces: the cohesion strength of the strippable material, the
4 adhesion strength between the thin film and the strippable material, and the
5 adhesion strength between the strippable material and the substrate.

1 58. A process for forming on a substrate a patterned thin film structure
2 in the shape of a decorative design, comprising:
3 printing with a printable material on the top surface of the substrate a
4 pattern that defines the area where the thin film structure is to be formed
5 by comprising a positive image of the decorative design such that the
6 printable material is printed in the area where the thin film structure is to
7 be formed;
8 depositing a thin film layer on the patterned top surface of the substrate,
9 wherein the thin film, the printable material, and the substrate are chosen
10 so that the thin film adheres more strongly to the printable material than
11 to the substrate; and
12 stripping from the substrate the portions of the thin film formed directly on
13 the substrate using a stripping process that does not strip the thin film
14 from the printable material such that the thin film structure remains
15 formed on the printable material used to define the area in which the thin
16 film structure was to be formed;
17 wherein the substrate and the patterned thin film design formed thereon
18 are suitable for use as an in-mold decoration (IMD) decorated film.

1 59. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the printable material comprises a
3 primer coating, adhesive, tie coat, or adhesion promoting material.

1 60. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the printable material comprises ink.

1 61. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the printable material is radiation
3 curable.

1 62. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the printable material is thermal
3 curable.

1 63. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the step of stripping comprises using
3 solvent to remove the portions of the thin film material formed directly on the
4 substrate.

1 64. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the step of stripping comprises using
3 mechanical pressure to remove the portions of the thin film formed directly on
4 the substrate.

1 65. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 64, wherein using mechanical pressure comprises
3 brushing.

1 66. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 64, wherein using mechanical pressure comprises
3 using a spray nozzle.

1 67. The process for forming a patterned thin film structure on a
2 substrate as recited in claim 58, wherein the printable material comprises a first
3 adhesive, adhesion promoting or tie material and the step of stripping
4 comprises:
5 applying a second adhesive layer to the substrate after the thin film
6 deposition step; and removing the thin film material on the area without
7 the first printed adhesive or adhesion promoting material by peeling off
8 the second adhesive layer.

1 68. The method of claim 67, wherein the adhesion strength between
2 thin film and the substrate is the weakest as compared to the cohesion strength
3 of the second adhesive layer, the cohesion strength of the first adhesive or
4 adhesion promoting material, the cohesion strength of the thin film, the adhesion
5 strength between the thin film and the second adhesive layer, and the adhesion
6 between the thin film and the first adhesive or adhesion promoting material.